

SCIENCE.

FRIDAY, JUNE 25, 1886.

COMMENT AND CRITICISM.

NEW HAMPSHIRE is more frequently visited by earthquakes than any other New England state; area for area, it is probably more often shaken than any other part of the United States east of the Rocky Mountains: but we have as yet very little definite information about its shocks. It is probable, from recent studies, that the area affected by a single disturbance is much larger than has been supposed. Systematic collection of records for a number of years is needed; and to this end, members of the Appalachian Mountain club have recently been urged by Mr. W. M. Davis of Cambridge to interest residents in New Hampshire, and elsewhere in New England, to report promptly any earthquake they may feel, noting its date, time (accurately), duration (in seconds), sound, and relative violence (very light, light, moderate, strong, or severe). On the receipt of such report, assistance will be given by the U. S. geological survey to trace the extent of the area affected.

SOME OF THE DIFFICULTIES of forest-culture in the British empire were well brought out at the meeting, May 4, of the select committee of the house of commons, appointed on the motion of Sir John Lubbock to take evidence upon the subject of forestry, with a view to the desirability of establishing a school of forestry. Dr. Scليه, director-general of Indian forestry administration, in answer to Sir John Lubbock, said that there was a fair field for investing a certain amount of capital in woodland, provided the woods were planted on surplus lands, and not on lands required for agriculture. He did not believe that lands which could be made useful for agriculture would yield the same terms if put in woodland. There was a considerable quantity of waste land in that country which could be set aside for woodland without infringing upon the land required for agriculture. The establishment of a school of forestry would be most valuable, because it would disseminate better views with regard to the management of woods. The Indian government had always been most anxious to help the colonies,

and had sent forestry officers to Ceylon, to the Cape, and to Cyprus; but those officers always returned to India because the colonies would not offer them proper terms. The colonies wanted to have men, and to be able to discharge them at their will and pleasure. The Indian government objected to sending away experienced men for the best portion of their working lives, and then to have them return to India in order to be pensioned off. If he were an owner of woods in England under existing conditions, he would probably said his wood bailiff for some time as an apprentice to a shrewd Scotch forester; if there was a school of forestry, he would probably send him to that. A very large quantity of land in Ireland was suitable for woodland; and practically about seven per cent of the land in Scotland was waste land.

THE NEW YORK LEGISLATURE has passed a law for the regulation and control of the practice of veterinary medicine. The law requires the registration of all practitioners, with the evidence of proper qualification afforded by a diploma from some legally incorporated college, or a certificate from an incorporated veterinary society. New York is the first and only state in the union to recognize and protect this profession, as it was the first to establish veterinary schools and to organize a state veterinary society.

IN CONNECTION WITH the article in *Science* of June 18, on a 'Final buffalo-hunt,' it is interesting to note the prospectus of the North-west buffalo-breeding company. This prospectus sets forth that Mr. S. L. Bedson, warden of the Manitoba penitentiary, a few years ago became possessed of a young buffalo-bull and four heifer calves, which have so increased that he now has a herd of eighteen bulls, twenty-five cows, and eighteen calves, all thoroughbred; that, experimenting by crossing with ordinary native cattle, he has found the half-breed possesses largely the characteristics of the thoroughbred, differing only in color, which will make the robe more valuable on account of its novelty; and, further, that, by judiciously crossing the thoroughbred bull with the half-breed cows, he has grown three quarter-

breeds, which closely resemble the buffalo, the head and robes being quite equal, if not superior. Besides the breeding of absolutely thoroughbred buffalo, it is the plan to breed "from selected native or imported Scotch cattle a half-breed that will supply the demand for a perfect buffalo-head; a robe equal in all respects, if not superior, to the best now in the market; and a beef possessing the venison-like taste and nutritious qualities of the pure stock of the plains." The three strong points of the new animal are to be his noble head, his pelt, and his flesh.

AS HAVING A BEARING on the value of the work of the U. S. fish commission, we are glad to give the following figures. The aggregate catch of shad on the Atlantic coast the present year is the largest that has been made since 1872. The Potomac River fisheries show an increase of nearly 100,000 shad over last season. The largest proportion of the catch in the Chesapeake and its tributaries is, however, made by the pound nets in salt or brackish water. The Hudson River was first stocked by the U. S. fish commission with the young of the Atlantic salmon in the spring of 1884. Well-grown sea-run fish weighing from ten to sixteen pounds are being taken at the Troy dam, and there is every reason to expect that the salmon will be permanently established in the Hudson River and its tributaries. The rainbow or California trout which was first introduced on the east coast in 1879, and which has been planted in a number of streams in Pennsylvania, Virginia, Tennessee, Alabama, and North Carolina in the last two or three years, is now being taken by anglers in various localities. Quite a number of specimens have recently been taken in the Holston River in the vicinity of Marion, Va., some of them measuring over eighteen inches in length. This stream was stocked with yearling California trout in the spring of 1884.

PETROLEUM AND NATURAL GAS AS FOUND IN OHIO.

THE introduction of natural gas into Pittsburg and other towns of western Pennsylvania within the last two years, and the marked advantages to manufacturing industries accruing therefrom, have made a great impression on surrounding districts, and especially upon Ohio.

In the last-named state an eager search for the new fuel has been entered upon, and is still going forward at a number of the industrial centres.

As a result, many interesting geological facts have been brought to light, some of which have great economic importance. Additions have also been made to our knowledge of petroleum and natural gas. A few of the leading facts that have been established in this connection, and some of the conclusions that seem warranted from them, will be given here.

1. Petroleum and natural gas do not need to be considered apart: they are products of the same strata. Every gas-rock is an oil-rock as well, and all rocks that contain oil contain gas also. These products are often intimately associated in the reservoirs, appearing simultaneously when the rock is pierced by the drill; but in some cases gas only is produced.

When, however, the rock which produces so-called dry gas is followed far enough, it is always found to contain oil as well. Generally the two products are at no great remove from each other. Their separation seems referable to geological structure, as will presently be shown, the gas occupying the higher portions of the common reservoir.

2. The origin of petroleum and gas from organic matter as opposed to the so-called chemical or inorganic theories of their origin, is strongly supported by the facts here furnished. The chemical theories require temperatures high enough to leave ineffaceable marks on the strata from which the petroleum is derived; but no such marks are found in the borings of even the deepest Ohio wells, and some of these wells nearly exhaust the paleozoic scale. There are no igneous intrusions, and no disturbances whatever of the sort that accompany metamorphic action; but from top to bottom the series is normal in all respects, affected only by light dips and low folds.

It is also found that different strata in the same series contain petroleum and gas of different characters: in other words, the character of the product is definitely related to the character of the receptacle and of the strata directly associated therewith.

3. Petroleum exists as such in Ohio rocks. It is actual, and not merely potential. There is no proof that it is now forming. For any thing that appears, the stock contained in the rocks may have been formed contemporaneously with the beds that contain it. There is, it is true, in addition to this petroleum content, a considerable percentage of organic matter in some formations, as in the black shale, which can be converted into gas and oil by destructive distillation, and, so far as we know, by this process alone; but, as shown in the preceding section, there is nothing whatever to lead us to believe that the process of destructive dis-

tillation has ever been applied, least of all that it is being applied, to Ohio rocks. The claim is sometimes made for an agency of manufacture called 'spontaneous distillation;' but, so far as can be seen, this is a human invention, and not a natural process. Instead of furnishing an explanation, it begs the question at issue. Destructive distillation we know, and chemical decomposition, in its various phases, we know; but what is 'spontaneous distillation' as an agency for the formation of petroleum from organic matter?

4. The wide diffusion of petroleum and its derivatives is well illustrated by the facts recently developed in Ohio. It is a mistaken view that these substances are of rare occurrence. Valuable accumulations, of course, are rare, but their presence in measurable quantity is well-nigh universal in the paleozoic rocks of the Mississippi valley. Prof. N. W. Lord, chemist of the Ohio geological survey, has recently examined the black shale of the state with this reference. He finds in normal shale more than two-tenths of one per cent of heavy oil. This amount he has weighed, but, from the nature of the processes he was obliged to use, he is certain that he has not obtained all that was present in the shale. Petroleum as such, or compounds derived from petroleum, as asphaltic grains or films, are also found in all of our principal limestones. Dr. Hunt reported, a number of years ago, more than four per cent of petroleum, or bituminous matter which was undoubtedly derived from petroleum, in the Niagara limestone of Bridgeport, near Chicago. These figures can be duplicated in some phases of the upper Silurian limestones of Ohio.

5. The amount of petroleum stored in the rocks is seen to be enormous. Take the figures of Professor Lord, already quoted. Two-tenths of one per cent of petroleum in a rock represents more than twenty thousand barrels to the square mile for every foot in depth. But the black shale is on its outcrop three hundred feet in thickness, and in the interior the formation is from four to six times as thick. Three hundred feet of shale would contain, to the square mile, six million barrels of petroleum. Suppose the rate given above is too high: divide it by two, by four, by eight, and even the last result would show nearly as much petroleum as has ever been taken from any square mile of the Pennsylvania fields.

6. The old dispute as to whether petroleum is mainly derived from bituminous shales or bituminous limestones has become 'a past issue,' largely through recent developments in Ohio. No question relating to the geology of petroleum has been more warmly or ably discussed. As so often happens, both sides were right in their main affir-

mations, and both were wrong in what they denied. The petroleum and gas of eastern Ohio, and, by the same token, of western Pennsylvania and New York, are unquestionably derived from the great shale formation of Devonian and sub-carboniferous age that underlies this territory, and they are stored in sandstones overlying or interstratified with these shales. The petroleum and gas of north-western Ohio are as certainly derived from good normal Trenton limestone that is at least five hundred feet thick, and underneath which no shales are known to exist.

That the oil and gas of eastern Ohio are derived from the shales, and not from the sandstones in which they are now found, becomes evident from the fact already noted; viz., that the underlying shales always contain a measurable amount of petroleum, while the Berea grit, which is the main Ohio reservoir, is everywhere, in outcrop and under deepest cover, a clean, sharp sandstone, remarkably free from organic remains of all description. *Ex nihilo, nihil fit.* If the source of oil were to be found in a sandstone containing organic remains, the Logan conglomerate (Pocono) should be a much more productive rock than the Berea grit. It is ten times as thick, and several times as coarse, and contains a profusion of sandstone casts of tree-trunks; but it is underlain with light-colored instead of black shale. It is the great salt-water sand of eastern Ohio, and is but rarely petroliferous on any considerable scale.

7. The gas and oil derived from bituminous shales are found to differ in composition, to some extent, from limestone oil and gas. In particular, the latter are never free from small percentages of sulphur compounds, none of which appear in the gas or oil of the shale. These compounds advertise themselves wherever they occur, and make the most noticeable characteristic of these oils.

The composition of Pittsburg gas is reported as very variable, even from the same well. All the observations on the limestone gas of Ohio show it to be remarkably steady and uniform.

Mr. S. A. Ford, chemist of the Edgar Thompson steel-works, gives a number of important facts concerning the composition of Pennsylvania gas in a recent number of the *American manufacturer* (Natural gas supplement, April, 1886). He gives the composition of what he counts average Pittsburg gas, as follows:—

Pittsburg gas.

Hydrogen.....	22.00
Marsh-gas.....	67.00
Ethylid hydride.....	5.00
Olefiant gas.....	1.00
Nitrogen.....	3.00
Carbonic acid.....	0.60
Carbonic oxide.....	0.60
Oxygen.....	0.80

The composition of the limestone gas of north-western Ohio (Findlay gas) is quite different, as appears from the following analysis made by Prof. C. C. Howard of Columbus, for the Ohio survey:—

<i>Findlay gas.</i>	
Hydrogen.....	2 18
Marsh-gas.....	92.60
Olefiant gas.....	0.31
Nitrogen.....	3.61
Carbonic acid.....	0.50
Carbonic oxide.....	0.26
Oxygen.....	0.34
Hydrogen sulphide.....	0 20

There are 125.8 grains of sulphur in 100 cubic feet of this gas.

Analyses made a year apart show that the constitution of the gas has remained practically unchanged during this interval.

The reference of the gas or oil of shales to limestones, or of the gas or oil of limestones to shales, is seen, in the light of these facts, to be inadmissible. The two series are distinct. These facts also furnish an additional argument against the chemical theory of origin of the petroleum series. Such an origin would seem to insure identity of composition to at least the oils of a single district.

8. Gas and oil are accumulated in more or less porous rocks that act as reservoirs. These reservoirs may be continuous with the source, or they may be distinct. In the case of limestone oil and gas, the first of these conditions is found. The stocks that are held in sandstones come under the second head.

While there are many horizons of gas and oil in Ohio rocks, covering the three main elements of the series, — viz., sandstone, limestone, and shale, — there are two of paramount importance; viz., the Trenton limestone and the Berea grit. The Trenton limestone nowhere rises to the surface in Ohio. It was first discovered to be a storehouse of high-pressure gas at Findlay in November, 1884. It is now yielding both gas and oil in large amount in at least three counties of northern Ohio, — viz., Hancock, Allen, and Wood, — and it promises to become by far the most important source of these products in the state. The section by which it is reached in the productive districts is as follows:—

200'-400'	Limestone, upper Silurian..	{ Waterlime. Niagara. Clinton.
800'-1000'	Shale, mainly lower Silurian	{ Medina. Hudson River. Utica.
500'	Trenton limestone.....	{ Gas and oil accumulated in uppermost beds, often at upper boundary, and never more than 40 feet below.

The main production of this new horizon has, so far, been limited to points where its upper boundary ranges between three hundred and five hundred feet below sea-level. It has been reached in at least a hundred drill-holes within the last year, through a district which would include from eight thousand to ten thousand square miles. The composition is shown by the following analyses of the gas-rock of Findlay and the oil-rock of Lima, which are one and the same thing.

	Findlay.	Lima.
Carbonate of lime.....	47.05	52.66
Carbonate of magnesia.....	33.38	37.53
Residue, mainly siliceous.....	11.73	4.15

The rock is highly crystalline and porous, and the greatest porosity seems to belong to the most productive portions.

The Berea grit becomes petroliferous from the moment that it takes cover. The oil of Mecca and of Grafton is derived almost from the outcrop of the rock. In the first instance, indeed, it has only the boulder clay for a roof; and, in the second, there are but from forty to sixty feet of Berea and Cuyahoga shale above it. It is only where it descends deeper, however, that it holds large stocks of gas or oil. The lightest cover under which large accumulation has been found in Ohio is six hundred feet, while in the Macksburg field, which is at present the main centre of production from this horizon, the stratum is at least twelve hundred feet below the valley level. The section found here is approximately as follows:—

Coal-measure strata.....	500'-800'
Conglomerate measures	200'-300'
Logan conglomerate (salt-water sand).....	200'
Cuyahoga shale.....	300'
Berea shale	30'-50'
Berea grit.....	5'-25'

There are two distinct oil-sands in the coal-measures, and one in the conglomerate group in this section, in addition to the Berea.

These reservoirs, whether sandstone or limestone, are permeable, and often communicate freely through considerable space. The gas-wells of Findlay are quite unequal in production, ranging between one hundred thousand and twelve million cubic feet per day; but when shut in, all show the same pressure. This pressure is now a little less than four hundred pounds to the square inch. It is called the rock-pressure. A large well, when shut in, comes up to this point quickly, and a small well slowly, but all get to the

same point. The flow of the well seems to depend on the porosity of its immediate reservoir. Free communication is also shown in adjacent portions of the Berea grit, but there is nothing to indicate an indefinite or universal permeability. The changes in the grain and thickness of the stratum would naturally divide it into basins approximately distinct from each other.

9. Every oil-rock has a more or less impervious cover, generally fine-grained shale. To constitute an oil-group, three elements are essential; viz., a source, a reservoir, and a cover. The first and second may coalesce, as has been already shown, but the third must be distinct and well-characterized. First in order of importance, as a matter of course, is the source, but so generally is petroleum distributed through the rocks of our scale, that its presence may almost be taken for granted. Practically, the character of the overlying mass is a chief factor. Almost any rock of the Ohio series, if covered by a heavy mass of shale, shows oil or gas when reached by the drill. The Utica, Hudson River, and Medina shales cover the oil-bearing Trenton limestone: the Berea and Cuyahoga shales overlie the petroliferous Berea grit. The corniferous limestone, which is covered by the heavy deposit of the Ohio shale, ought by this order to be also a source of oil. It has been found to be so in Canada, but not yet in Ohio.

10. One other factor is found to be of prime importance in oil and gas production; viz., geological structure. Source, reservoir, and cover may each be complete in itself, and yet no accumulation of either product may result. Illustrations are found in both of the main Ohio horizons.

For many thousand square miles, the relations of the several elements of the series that has proved petroliferous in north-western Ohio are absolutely identical. A hundred wells have now been drilled in this field, and the records of the series traversed are monotonous repetitions of one another. From one you can learn all. Not only is there the same order, the same thickness, the same color, but there is substantially the same chemical constitution of each stratum throughout its entire extent. In all cases there is some accumulation of gas and oil, but generally slight, at the top of the Trenton limestone.

But at one point, as the drill has now shown, in a drift-covered plain, where all the facts were hopelessly obscured to other reading, the steepest dip known in Ohio rocks has been brought to light. Two terraces of Trenton limestone, with their superincumbent strata, are made known to us, one of which is about 310 feet (306, 312, 314) below tide, and the other of which is about 475 feet below. The slope of 165 feet that connects them

occupies a little more than a half-mile in breadth. What effect does this marked structural feature seem to have on oil or gas accumulation? On the upper terrace, every well that has been drilled has found a fair supply of gas without oil. The wells of the lower terrace are all oil-wells, though containing considerable gas also. And what of the wells on the slope? That depends on what part of the slope they occupy. On the upper edge, from 330 feet below tide to 350 below, there is a belt of the most remarkable and valuable gas-wells ever struck in the state. The famous Karg well produces, by the lowest measurement, 12,000,000 cubic feet per day. The Trenton limestone was found in it 347 feet below tide. In the next well in order of production, the surface of the limestone was 350 feet, and in the third well 330 feet, below the sea.

Seven wells have been drilled on the slope in which the limestone is between 330 and 350 feet below tide. One of the number is a small producer, but the smallest of the six remaining wells yields more than 1,000,000 cubic feet of gas per day.

Descending the slope still farther, we come to a group of three wells, in which the Trenton limestone lies respectively 394, 403, and 405 feet below tide. All of them were vigorous gas-wells when first drilled, but they also yielded more or less oil from the first. Little by little, however, their character has been changed, oil and salt water overpowering the gas, until now almost their sole value is found in the oil that they produce.

The facts above given come from the Findlay field. Similar facts are found at other centres of production of Trenton oil and gas.

Equally satisfactory testimony as to the all-important influence of structure on gas and oil production is supplied by the facts of the Berea grit. This remarkable stratum, the first persistent sandstone to be reached in ascending the geological scale of the state, has a bold outcrop from the Ohio valley to Lake Erie, and thence eastwards toward Pennsylvania. Scores of quarries are located along this outcrop, from which is derived some of the most valuable building-stone of the country. The stratum dips gently down from its outcrops at the rate of from fifteen to thirty feet to the mile. It holds its continuity underneath the whole of eastern Ohio. Its area in this state, therefore, is not less than twenty thousand square miles. Slight rolls traverse it, breaking up the monotony of its descent. These rolls, or interruptions of dip, connect themselves at once with gas and oil accumulation. A single example, and the one most carefully worked out, must suffice.

In the vicinity of Macksburg, north of Marietta, the light south-eastward dip of the strata is found to be interrupted, and for nearly a mile a terrace-like structure prevails. This is masked, it is true, by the immense erosion which the country has suffered, and only comes into view when the best-known elements of the exposed section as coal-seams are followed by means of the level. All of the strata ever reached by the drill, as well as all that are above the surface, are equally affected by this structural irregularity.

But this terrace is an oil-field, and has been for twenty years. Oil was first found here in shallow wells, from two hundred to three hundred feet deep in the upper Mahoning sandstone. But adventurous drillers, one after another, struck new sources of oil. A second oil-sand, and a third, were discovered at five hundred and seven hundred feet respectively. Finally the drill was sunk deeper still, until, at thirteen hundred feet, the Berea grit was found, holding a stock of oil large enough to make the Macksburg field for the first time a factor in the general market. It has produced as many as three thousand barrels per day since then, and is now yielding twenty-five hundred barrels per day.

But the shallow and the deep productive wells are alike definitely limited to the terrace that has been described. In other words, four oil-sandstones become productive in the same area when the structure is found favorable. That they do not communicate with each other is evident from the fact that the oils which they severally contain differ from each other in gravity, in color, and in chemical constitution.

The depth of the Berea grit below sea-level in the terrace is 735 feet. Of twenty-four wells, occupying four square miles in this field, sixteen reach the Berea between 733 and 737 feet, and six are found by their records to be exactly 735 feet.

On the north-western margin of the terrace, at elevations of 728, 720, 713, and 704 feet, gas is found, but no oil. After many hundred wells have been drilled on all sides, the terrace which has been revealed by the engineer's level is alone found productive.

The grain of the sandstone is in every way as promising, and its thickness as great, outside of the field as within it; and the sections both above and a thousand feet below the Berea grit appear identical in productive and in barren territory alike. It is hard to resist the conclusion that the Macksburg oil-field is dependent upon the structural irregularity here described, the other elements, of course, being presupposed.

May not a like explanation be applied to the oil and gas fields of Pennsylvania and New York as

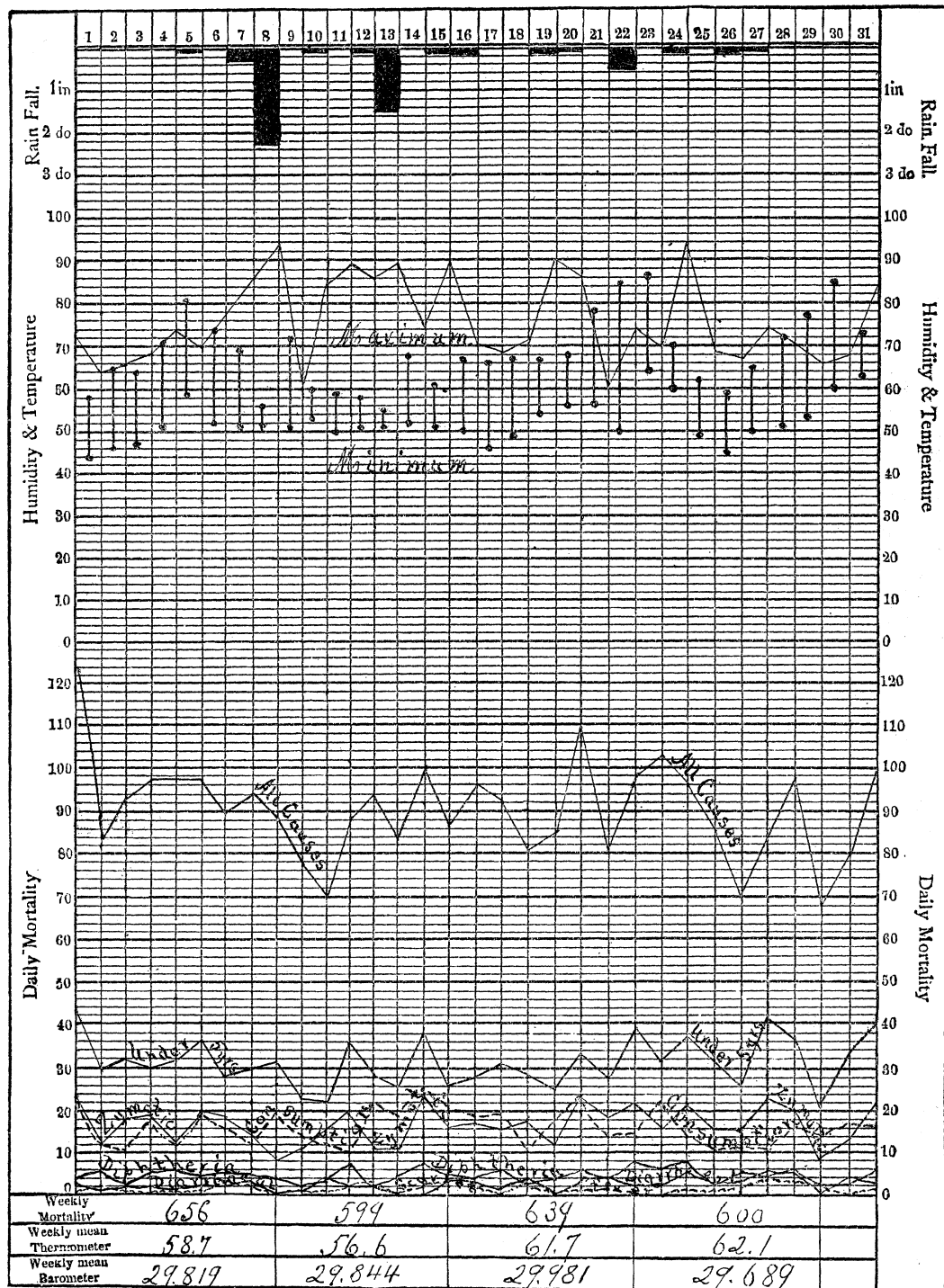
well? Is it not possible that their productive areas are also dependent on structural disturbance, slight though it may be? These areas have been sometimes explained as resulting mainly from the coarseness of grain of the oil-sands. Lenticular deposits of gravel have been suggested, arranged in north-east and south-west lines for the several petroliferous horizons. It is hard to see how any one of these long tongues of gravel could be accounted for, laid down so far from the shore of the sea in which it was deposited. It is much harder to understand how, as the geological ages went by, one after another of these peculiar deposits should be laid down on these self-same lines. It is certainly much easier to conceive of the oil-sands as wide-spread sheets of sand and gravel, that become the reservoirs of oil and gas when lifted into elementary folds. This is certainly true of the Berea grit in Ohio, and this great stratum, it is now definitely settled, constitutes one of the main oil-sands of Pennsylvania. Under this view, the arrangement of the several oil-fields in north-east and south-west lines becomes easily intelligible. These oil-fields are simply conforming to, as they are determined by, the main structure-lines of western Pennsylvania.

EDWARD ORTON.

THE HEALTH OF NEW YORK DURING MAY.

THE population of the city of New York on May 1 was estimated at 1,432,094. Assuming the normal increase to be 799 each week, there would be, June 1, a population of about 1,435,290. Of this number, 2,759 died during the month of May, a mortality less by 206 than occurred during the preceding month. Of children under five years of age, there was a saving of 110 lives as compared with April. The greatest mortality from all causes which occurred during any one day was on the 20th, when 107 persons died. Of this number, 24 were children under one year of age, 29 under two years, and 34 under five years. Consumption caused more deaths on that day, as indeed it usually does on most days of the year, than any other single disease, its victims being 24. The deaths during the month from diarrhoeal diseases were 73, an increase of 16 over the month of April. Diphtheria also caused a considerable increase, its deaths being 165 against 124. Scarlet-fever maintained the same position among the mortality-factors which it had occupied for the two preceding months: the deaths from this disease in March were 42; in April, 49; and in May, 44.

It will be remembered that while rain fell on



but few days in the month of April, only seven, yet the aggregate rainfall was about the average for the same month in preceding years. May was in all respects a month of showers: on fourteen of its days rain fell to a greater or less amount; and the total for the month was 5.40 inches. During the same month in 1885, although some rain fell on thirteen days of the thirty-one, but one less day than this year, yet the total rainfall for the month was but 1.86 inches. As will be seen by the chart, the greater part of the rain this year fell on the 8th and 13th insts. An examination of the records for the past seventeen years fails to show such a rainfall during May, the nearest approach being in the year 1882, when 4.20 inches fell. If, however, we continue our search still further back, we shall find a number of years in which this rainfall is surpassed, and in one year, 1846, nearly doubled, it being then 10.25 inches. The highest point reached by the thermometer was 86° F., on the 23d inst., at 5 P.M. On the preceding day the mercury rose to 84° F. at 4 P.M., and on the 30th it reached 85° F. at the same hour of the day.

A NEW EXPEDITION TO ALASKA.

THE New York *Times* has sent an exploring expedition to Alaska, the object of which is to explore the St. Elias range of mountains and the country between them and the sea, while an attempt will be made to ascend Mount St. Elias itself. The expedition is led by Lieut. Frederick Schwatka, who has already won deserved renown in arctic travel and research. In 1879 he led an expedition over the route of Sir John Franklin's party, and brought to the world its fullest and final knowledge of the fate of the *Erebus* and *Terror*. Again, in 1883, he explored from its source to its mouth Alaska's great river, the Yukon. It was in returning from this trip that Lieutenant Schwatka conceived the desire to visit the mountainous and forbidding southern coast of Alaska, and tell the world something of its Indian races, of its forests, its soil, and its glaciers. The *Times* has given him an opportunity to undertake this voyage of discovery and description, and it hopes in due time to lay before the public such additions to the world's present slight knowledge of this region as will amply justify the effort and the expense involved.

Lieutenant Schwatka himself has an article in a recent number of the *Times*, in which he says:—

"The New York *Times* Alaskan exploring expedition, which sailed on the Alaskan steamer *Ancon* from Port Townsend, Washington Territory, June 14, has for its object the exploration of

the almost wholly unknown St. Elias Alps, stretching for nearly 300 miles from the upper part of that picturesque lane of water called 'the inland passage to Alaska' to Mount St. Elias, the highest peak of the North American continent, and which throws its name over the whole range, and even beyond. The expedition, therefore, will have to do with mountain-climbing; and should opportunity present, which is very likely, attempts will be made to ascend, in whole or in part, some of the numerous peaks that project from that high range. Although, strictly speaking, this is not its main object, still it would be considered no small victory to crown the king of the American continent, Mount St. Elias, with shoe-leather of American make, and, but a little way behind this, to reach the summits of any of the others, — Crillon, Fairweather, La Perouse, Vancouver, Lituya, d'Agelet, — all higher than any peak short of the Rocky Mountain range. Should the top of the main range be gained, at 8,000 to 10,000 feet above sea-level, it is hoped — and the probabilities are great — that a bird's-eye view in the interior will compensate for all the trouble taken, and especially if this be done at several points along the main ridge. Bad weather, of course, could defeat much of this part of the plan, but during the summer months this is not very likely. The interior slopes may be descended if the prospect is at all flattering for important research and discovery of any kind; for toward the interior absolutely nothing is known of the country. Prof. William Libbey, jun., professor of physical geography in Princeton college, will have charge of the scientific work, and especially the hypsometrical and topographical part of it. He has been identified with considerable practical Alpine work in the past, both in our own and other countries. The well known hypsometrical and other scientific tables compiled by the late celebrated Professor Guyot (to whose chair at Princeton Professor Libbey succeeded on the former's death), and published by the Smithsonian institution at Washington, were recently revised under Professor Libbey's care, and brought up to the requirements of scientific advancement in that line since Professor Guyot's death. Many of the hypsometrical and other scientific instruments taken were once those of that celebrated geographer."

Of the scientific aims and prospects of the expedition, Lieutenant Schwatka writes as follows:—

"The glacier system of the Mount St. Elias Alps is undoubtedly the most extensive south of the arctic regions themselves. Just how extended it is cannot be told until further exploration gives more data. It will probably be many years before

it is well outlined, as no one exploration could encompass the whole of it. One bay alone has some six or seven glaciers coming down from the southern spurs of these Alaskan Alps just off the summits of Mounts Fairweather and Crillon, which, dipping into the sea, snap off into icebergs that float away nearly as high as the masts of the excursion steamers that visit this bay — called Glacier Bay — monthly during the spring and summer. From Glacier Bay northward to beyond Icy Bay (just seaward from Mount St. Elias) there can be seen these huge rivers of solid ice coming down to the sea; one, Le Grand Plateau, so named by La Perouse, its discoverer, being probably the largest one of the immense group covering so wide a territory. It is quite evident, if the expedition accomplishes any thing, that no small share of it will be in this particular field of research.

"Between the St. Elias Alps and the sea — the Pacific Ocean — is a narrow strip of flat lands where the Indians live, and which, from the ocean, seems to be heavily wooded. It is proposed to find out the status of this timber and that on the foothills of the Alps, as far as it is possible without spending too much time upon it. If fine forests of merchantable timber are found, which is not at all unlikely, it is known that there are good harbors here which will make it quite accessible, and give value to the discovery. If any thing near as valuable as the present yellow cedar forests of the shores of the inland passage of Alaska can be found, the expedition will be a double success from this very fact.

"In the way of precious minerals there is the usual prospect of seeing them; and while the search for them is probably the last on the list of undertakings, if at all, the party will not go by any mountains of gold or silver without at least taking a photograph of them.

"It is hardly to be hoped that the country is much richer in furs than the general average of the Alaska mainland; but, should it fortunately prove otherwise, the public shall know of it in due time.

"Agriculturally there is little to be expected in such a rough Alpine country; but if the low flats known to exist along the coast are not too marshy, and have fertile soil, there is nothing to prevent their being cultivated to the fullest extent, in which case it would be doubly valuable by there being no other agricultural lands near by.

"Of the Indians living here, but very little is known; and this very fact is somewhat in favor of the expedition, as among these little known savages there is every reason to suppose that a rich ethnological collection can be made, which

will not only shed some light on the people themselves, but on adjoining tribes that are somewhat spoiled for ethnological purposes by long contact with white men and civilization."

The exploring party is well supplied with arms and ammunition, as well as with food; and the precise course to be pursued by them is left largely to the discretion of the commander. When the expedition will return depends largely on its success; for Lieutenant Schwatka is determined not to return until he has accomplished something worthy of the expenditure of time and money. He hopes, however, to be back to the Alaskan coast by September of the present year.

ASTRONOMICAL NOTES.

The large dome for the Lick observatory. — At the meeting of the Royal astronomical society on May 14, Mr. Grubb, the well-known Dublin instrument-maker, presented a model of an equatorial mounting and dome which he had designed, at the request of the Lick trustees, for their 36-inch objective. The main idea throughout was to bring under the direct control of the observer all the required motions of the instrument and of the dome, so as to give him as little physical exertion as possible. To effect this the motive power was to be a number of small water-engines, controlled by an electrical apparatus which the observer could carry about with him. A tap on one key will turn the dome in one direction; another will reverse the dome; a third key will control the telescope in right ascension, and another in declination; and so on; while there is one for lighting up the observatory; and lastly, in order that the observer shall have as little difficulty as possible in getting into a position to observe, instead of climbing into a chair which would perhaps require to be twenty-five feet high, a key is provided which will make the whole floor move up or down. During the discussion upon this ingenious device, Mr. Common quoted the following paragraph from Professor Holden in regard to the prospects of completing the observatory: "We hope during the early part of 1887 that we may see the objective, both photographically and visually, completely finished, and perhaps delivered in California. Our large dome will undoubtedly be finished during the current year; and we look forward to commencing serious work with the whole observatory during the year 1887, and possibly sooner." The contracts for the mounting and dome, if any have yet been made by the Lick trustees, are not yet public.

Change of latitude. — Miss Alice Lamb, assistant astronomer at the Washburn observatory, has, in the June number of the *Sidereal messenger*, given

the results of a critical examination of the latitude observations made by army engineer officers at Willets Point during the year 1885. These observations are of peculiar interest from their bearing upon the mooted question of the variability of terrestrial latitudes; but it appears that the sequence of the results from 1880 to 1884, which seemed to indicate a gradual decrease of latitude, is interrupted by the result for 1885, which is practically the same as that for 1881. The conclusion which Miss Lamb reached from a similar discussion of previous observations (*Science*, vi. p. 118) is now further confirmed. The evidence seems to be rather against a systematic change of latitude at Willets Point, though the results for future years will be awaited with interest.

Astronomical activity.—In looking over the reports of observatories for the year 1885, one cannot but be impressed with the increase of activity in all branches of observational astronomy. Greenwich has ordered a 28-inch refractor for spectroscopic work; Struve at Pulkowa, with the new 30-inch, can go deeper than ever into the star depths for faint 'doubles'; the Vienna 27-inch, in the hands of Dr. Vogel, has already done good work in astronomical physics; and Paris has taken the front rank in stellar photography. The interesting report of Admiral Moucher, the director of the Paris observatory, now before us, gives especial prominence to this comparatively new method of research. A reproduction of a photograph of the Pleiades, taken by the Henry Brothers with an exposure of one hour, has suggested a comparison with Wolf's well-known chart of that group, upon which he spent three years' labor, and the advantage of photography in certain directions is strongly brought out. Wolf's chart contains 671 stars, the limit being the 13th magnitude; while the photograph shows no less than 1,421, the faintest being of about the 16th magnitude. In the meridian service over sixteen thousand observations have been made by sixteen different observers; the instrument devised by M. Loewy, the *equatorial coudé*, has been brought into regular use for observations of comets and minor planets; and the time service, meteorological department, etc., are all in a most satisfactory condition. A department of the observatory which we should like to see imitated in this country is the 'Ecole d'astronomie,' in which courses of instruction are given by such members of the observatory staff as Loewy, Tisserand, Gaillot, and Perigaud. The students are given employment in the computing bureau, and, after sufficient instruction, they take part in the observations with the meridian instruments. The schools of astronomy in this country are not very thriving adjuncts of our colleges.

NOTES AND NEWS.

THE following appropriations are recommended by the committee on appropriations for the various scientific departments of the government for the fiscal year ending June 30, 1887:—coast survey, \$407,246, being \$146,250 less than was appropriated the past year; the number of field officers is reduced from 64 to 48; office force, from 103 to 91: geological survey, \$467,700, the same amount as was appropriated last year: signal service, \$799,493, being \$64,587 less than was appropriated last year: national museum, \$157,500, \$19,000 more than was appropriated last year: Smithsonian institution—international exchange, \$10,000; North American ethnology, \$40,000; being the same amounts as were appropriated last year: fish commission, \$220,040, being \$40 more than was appropriated last year.

—The final excursion of the geological class of the Academy of natural sciences of Philadelphia, extending over a period of about ten days, and beginning with the first week in July, will be directed to Nantucket and Martha's Vineyard. It is proposed to investigate the physical (geological and paleontological) features of the islands, and the recent fauna of the coast. The total expense, including the academy admission-fee of seven dollars, will not exceed thirty-five dollars.

—About twenty-five thousand deaths from typhoid-fever occur in this country annually, says the *Medical record*, and this represents fully one hundred and fifty thousand cases of the disease. Statistics show that there is no disease so easily preventable as this; and it is safe to say that fully one-half of this mortality might be saved by greater cleanliness and more attention to sewage.

—A new monthly magazine devoted to the now popular art of photography has just appeared in England under the appropriate title of the *Camera*. Mr. R. A. Proctor supplies an interesting paper on photography and astronomy, with illustrations of some of the recent results of observations; Dr. Lindsay Johnson and Mr. T. C. Hepworth also contribute useful articles; and a descriptive account of the amateur photographic exhibition in Bond Street, with reproductions of some of the principal examples, is carefully written.

—Letters from Colonel Lockhart's mission, dated May 9, have reached India. The party were then near Gumbaz, on the northern slopes of the Hindoo-Koosh. They had gone northward from Gilghit, through Hunza, and would work along the Hindoo-Koosh, and enter Kafirstan from the north.

—Dr. Julius Stöckhardt, the well-known agri-

cultural chemist, died at Tharandt, in Saxony, on the 1st of June, in his seventy-seventh year.

— The *Athenaeum* of June 12 states that arrangements are being made for holding an international congress for discussing papers upon climatology, mineral and thermal springs, and allied subjects at Biarritz, under the presidency of Dr. Durand Fardel, the first week in October, to be followed by a three-weeks' tour to the principal watering-places of southern France.

— The *Athenaeum* chronicles the appearance of a new Italian journal of zoölogy, entitled *Bolletino dei musei di zoologia ed anatomia comparata della R. università di Torino*. At Jena an *Anatomischer anzeiger*, under the editorship of Prof. K. Bardeleben, is announced to begin its existence this month.

— The following is a list of the publications of the geological survey now in the hands of the public printer:— Sixth annual report of the director: Monographs — Lamellibranchiata of New Jersey, by Whitfield; Dinocerata, by Marsh; Geologic history of Lake Lahontan, by Russell; Geology and mining industry of Leadville, by Emmons; Geology of the Eureka district, by Hague; Lake Bonneville, by Gilbert; Stegosauria, by Marsh: Bulletins — Work done in the division of chemistry and physics, 1884–85, by Clarke; Gabbros and associated hornblende rocks, by George H. Williams; Fresh-water invertebrates of N. A. Jurassic, by C. A. White; Cambrian faunas of N. A., by Walcott; Fossil insects, by Scudder; Mineral springs of the United States, by Peale; Geology of northern California, by Diller; Relation of the Laramie molluscan fauna to succeeding fresh-water eocene, by White; Physical properties of carburets, by Barus and Strouhal; Subsidence of small particles of insoluble solid in liquid, by Barus: A geologic map of the United States.

— Howard Ayers has been appointed as an instructor in zoölogy at Harvard college.

— Under the patronage of the Grand Duke of Baden, and with the concurrence of the grand ducal government, the Industrial society of Karlsruhe, says the Journal of the Society of arts, has organized an international exhibition of the manual arts and domestic economy, to remain open from Aug. 15 to Sept. 15, 1886. The principal object of the exhibition is to make known the best *matériel* and apparatus suitable for small industries, and to popularize their use; so that all small motors, tools, and machine tools will be welcomed.

— An important exhibition of apparatus and implements for the prevention of the diseases of

the vine, and for destroying insects that infest it, says the Journal of the Society of arts, was held last month at Conegliano. The exhibitors, who were not limited to Italians, were 197 in number; and of the 524 different machines, apparatus, and implements shown, 450 were connected with application of milk of lime, the most effectual remedy for the disease called peronospora, the proportion being from 8 to 10 of slaked lime to 100 of water. The experiments, made before a jury composed of the most eminent viticulturists and scientific men, which lasted five days, will be described in a report to the minister of agriculture, and will contain a variety of useful information and plates. Three gold medals, three silver with money prize of 150 francs, seven silver ones, and four bronze ones, were awarded, and, besides these, three special premiums were given by the local agricultural committee.

— The following changes have been made in the coast survey service since our last issue: Assistant Gresham Bradford has been ordered to Sandy Hook to make an examination for the location of a permanent self-registering tide-gauge; Lieut. F. S. Carter has been ordered to Baltimore to relieve Lieut. G. H. Peters of the command of the Arago, which has been ordered to New York; Ensign A. W. Dodd has been detached from the schooner Bache, and ordered to the Drift; Assistant J. B. Weir has been ordered to duty at the home office. The following parties engaged in state work have been recalled, owing to the failure, on the part of congress, to appropriate money for the continuance of this field-work: Prof. H. L. Barnard, Chambersburg, Penn.; Prof. A. H. Buchanan, Lebanon, Tenn.; Prof. J. E. Davies, Madison, Wis.; L. A. Bowser, New Brunswick, N. J.; Assistants E. F. Dickens and J. S. Lawson, Anaheim, Cal.; J. L. Campbell, Crawfordsville, Ind.; Prof. Mansfield Merriman, Bethlehem, Penn.

— The following charts will shortly be issued by the coast survey: Cape Flattery to Dixon's Entrance, and from latter point to Cape St. Elias; Head Harbor Island to Petit Manan, coast of Maine; Icy Bay to Semidi Islands, Alaska; topographical sheets of New York and Jersey City water-front from Battery to 68th Street, North River.

— Mr. A. Schuster has recently published (*Phil. mag.*, April, 1886) an analysis of certain observations on the daily variations in earth-magnetism which indicate definitely that the cause of the disturbances lies wholly without the earth.

— According to Professor Heim, says *Ciel et terre*, the total number of glaciers in the Alps is 1,155, of which 249 have a length greater than

four miles and a half (7,500 metres). They are distributed as follows: in France, 144; Italy, 78; Switzerland, 471; Austria, 462. Their total superficial area is between five hundred and a thousand square miles. The longest is the Aletsch glacier in Austria, measuring over nine miles.

— Dr. Freire of Rio de Janeiro, in a letter to the Louisiana state board of health, thus speaks of the results of his inoculation for yellow-fever: "I have performed over seven thousand inoculations with full success. The immunity was almost absolute, notwithstanding the intensity of the epidemic this year. More than three thousand persons who were not inoculated died of yellow-fever; while among the seven thousand inoculated, inhabiting the same infected localities, subject to the same morbid conditions, but seven or eight individuals, whose disease was diagnosed as yellow-fever, died."

— During the year 1885 there were 246 earthquakes, according to the statistics of C. Detaille, as given in the June number of *Astronomie*. The largest number of these, 49, occurred in January; the smallest, 11, in October. For the other months the numbers are as follows: February, 18; March, 15; April, 19; May, 14; June, 29; July, 23; August, 13; September, 16; November, 16. Only 6 are given for North America, as follows: Jan. 12, Washington; Jan. 18, New Hampshire, Carolina; Jan. 26, California; Feb. 5, Virginia; Nov. 19, California.

— A. Raggi has published some observations on the intermittent variation in sound-perception in the human ear, instances of which are probably familiar to many persons. In deep stillness, if one listens to a faintly heard sound, like that of the ticking of a watch, it will be noticed that at irregular intervals the tones are wholly inaudible, while at other times they are distinctly recognized. Mr. Raggi ascertained, by experiments on different persons, that the intervals of silence usually varied between seven and twenty-two seconds; while the periods of sound-perception were between seven and eleven seconds in duration, with a maximum of fifteen. He also found that the variation was not due to extraneous sounds, nor to the blood-circulation or respiration, and concludes that it results from the inability to keep the attention for long periods at a sufficient degree of tension for the perception of faint sounds, or possibly to a variable physiological receptivity in the auditory nerves.

— A legacy of some \$75,000 has been left to the Jena university to be applied in zoölogical research on the basis of Darwin's evolution theory. The testator is Herr Paul von Ritter of Basle, who be-

lieves the teaching of Darwin to be the greatest sign of progress which the century has yet given.

— According to the statistics recently published by the minister of agriculture and commerce, it appears that the quantity of olive-oil produced last year, in the various provinces throughout Italy, was 52.34 per cent below the average annual yield, which is calculated at 3,405,500 hectolitres (74,921,000 gallons), it being only 1,782,400 hectolitres (39,212,800 gallons); 11 per cent of this total amount was of superior quality, 73 per cent good, and 16 per cent mediocre.

— The Royal academy of medicine of Belgium has recently offered its largest prize (\$5,000) for the most meritorious work or paper on the treatment of diseases of the nervous centres, especially for a remedy for epilepsy. The great need of some better means of controlling this last disease induced the academy to offer an additional prize of \$1,600 for the best paper on that subject. The prizes are international, and will be awarded in December, 1888.

— Late deep-sea explorations in the Atlantic, carried on under the auspices of the London geographical society, have shown that the ocean-bottom in the northern region is formed of two valleys, of which one, in width, reaches from the tenth degree of east to the thirtieth of west longitude, extending to the equator, at a depth of not less than thirteen thousand feet. The other lies between the thirtieth and fiftieth degrees of west longitude. The mountain-chain separating the two valleys extends northwards towards Iceland, and southward to the Azores, and is of a volcanic character at its ends. Its greatest breadth is a little less than five hundred miles.

LETTERS TO THE EDITOR.

*** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.

Is the ocean surface depressed?

Do barometric observations give any hint regarding the depression of the sea 'at the centre of the oceans'?

If, as is maintained, there be a depression of a thousand metres, the barometer should show about three inches and a half more pressure at the centre of the oceans than at what we ordinarily call sea-level.

Were there any barometric observations made on the islands where the pendulum was swung? or do barometric observations made on any of the oceanic islands cast any light on this subject? I have no authorities at hand to consult, or would not ask the question.

W. H. S.

Candelaria, Nev., May 25.

The notion that there exist in the sea-surface of the earth elevations and depressions amounting to several hundred metres has recently gained a much

wider acceptance than our knowledge of the facts would seem to justify.

Assuming the continents to be simply so much matter, of half the earth's mean density, on the surface of our otherwise closely centrobatic spheroid, it may be shown that individually they will draw the sea-surface up towards their centres by considerable amounts (about a thousand metres at most), leaving corresponding though not equal depressions opposite those centres; and that collectively they will produce a wavy sea-surface, in which the maximum radial distance from crest to hollow is about six hundred metres. The theory, and the equations assigning the form and position of this wavy surface, have been developed by Helmert in his excellent treatise on geodesy ('Die mathematischen und physikalischen theorien der höheren geodäsie'), from which the above figures have been taken. If we dropped our examination of the question at this point, we might infer the reality of the wavy surface just described. The existence of such assumed continents, however, implies a proportionate variation of gravity along the sea surface and along the same level surface extended through the continents. They would, for the most part, produce an excess of gravity over the continental and a deficiency over the sea areas. But this conclusion is in direct contradiction with the results of pendulum experiments. The assumption, therefore, that the continents are superficial masses, unbalanced in their attractive effects, is, as clearly shown by Helmert, inadequate, and must, together with the conclusions based thereon, be modified or rejected.

Some writers, notably Fischer and Listing, have proved the existence of a highly irregular sea-surface by a still more unsound process than that indicated above would be if we neglected to examine its fundamental assumption. This process, in brief, rejects in an equation a term of the same order as those retained, and arrives at a simple relation between the variation of gravity and the radial distance from the actual sea-surface (or geoid) to the mean spheroidal surface. Helmert fitly characterizes this relation as entirely worthless (*ganz wertlos*), since it fails in every case to give the proper sign when the increments of gravity and radial distance due to the combined action of the continents are substituted in it.

Those desiring to examine minutely the merits of this question should consult the above-named treatise of Helmert, who gives a critical review of the cognate works of Fischer, Listing, Bruns, and others. For the benefit of the general reader, it may be stated, that, although the sea-surface is undoubtedly somewhat irregular, geodesy and geology have as yet furnished no adequate evidence of irregularities amounting to more than ten metres. Additional information, of which it must be admitted there is great need, may disclose the existence of a surface having hills and hollows separated by an interval of fifty or possibly a hundred metres; but irregularities of any greater extent appear to be quite improbable.

The suggestion of your correspondent, that the barometer would indicate any large elevations or depressions in the sea-surface, is not well grounded. The surfaces of equal pressure in the atmosphere must approximate to parallelism with the sea-surface, however irregular it may be. In a state of quiescence the air-surface in contact with the sea

is necessarily a surface of equal pressure. The barometer would therefore, if moved from one point to another along the sea-surface, register only such variations in pressure as are due to changes of temperature, winds, etc., and hence afford no indication of the elevations and depressions in question, if they exist.

R. S. WOODWARD.

Washington, D.C., June 17.

Barometer exposure.

Mr. Clayton's letter concerning the influence of wind on the indication of the barometer broaches a subject of great importance to theoretic and practical meteorology, and I trust it may lead to the execution of the experiments essential to the intelligent treatment of the difficulty. As his conclusions are called in question by President LeConte, I take the liberty of rehearsing some investigations of my own which tend to sustain Mr. Clayton's conclusions.

In June, 1873, an elaborate series of synchronous barometric observations were made by the signal office at four stations on the summit and slope of Mount Washington. In testing a special method of barometric hypsometry, I had occasion to discuss these observations, and I discovered an important anomaly which was correlated with the velocity and direction of the wind. The discussion cannot be repeated here, for lack of space; but it may be said that its method and material were such as to leave no reasonable doubt that the wind was the disturbing factor, while they afforded quantitative results far more precise than can be reached by any method of reduction to sea-level. The reader who cares to examine them should consult the 'Second annual report of the U. S. geological survey,' pp. 521-534 and 562-565. One of the specific conclusions was, that a north-west wind of fifty miles per hour, by drawing air out of the summit observatory, presumably through the chimney, caused the mercury in the barometer to stand .13 of an inch too low; and it was estimated that a wind-velocity of a hundred miles would lower the mercury more than half an inch.

I think President LeConte is mistaken in supposing that the matter could be simply tested by comparing the indications of a barometer in a room with those of a barometer out of doors. If the out-of-door barometer were placed on the windward side of a building or other obstruction, and close to it, it would be immersed in compressed air, and read too high. If placed under the lee of an obstruction, it would be surrounded by relatively rarified air, and read too low. If placed in a position uninfluenced by obstructions, the locus of difficulty would be transferred from the surrounding atmosphere to the instrument itself, for the air chamber above the mercury in the cistern of the barometer would itself be influenced by the wind so as to receive a tension abnormally high or low. These statements, based on familiar physical laws, are not individually susceptible of ready verification, because, while the wind blows, all local tensions are disturbed, and we have no standard air-pressure for comparison. I have, however, determined experimentally that the reading is higher in front of an obstruction than behind it. A difference of .15 of an inch was found between barometer-readings on opposite sides of the apex of an acute mountain-peak.

In my opinion, the proper method of escaping the difficulty is, not to place the barometer out of doors, where observation during a wind is itself a matter

of difficulty, but to so arrange the observatory that the influence of the wind shall be either measured and subtracted, or avoided altogether. Place the barometer in an air-tight box, made partly of glass for purposes of observation, and connect this box by a tube with an opening on the roof so adjusted that it shall always sustain the same relation to the wind. It is possible that a form of opening can be devised such that the wind will neither compress nor dilate the air within the box; but, if this cannot be done, it is certainly possible, by a proper system of experiments, to determine for a given arrangement of aperture the proper correction to apply to the barometer-reading for each measured velocity of wind. The matter should receive thorough investigation.

G. K. GILBERT.

Washington, June 19.

I infer from Prof. John LeConte's letter in your last issue (*Science*, vol. vii. p. 550) that he does not feel entirely satisfied with the explanation I have offered of the slight fluctuations of the barograph observed at Blue Hill during high winds. He says, "The observed facts are, that fluctuations of wind-velocity correspond with fluctuations of air-pressure. In some cases it may be difficult to decide which is cause, and which is effect." In this case, the fact, as stated in my last letter, that I could produce these fluctuations at will by merely opening and closing a hatchway in the top of the building, seems to me to prove conclusively that the wind was the cause, and the change in the pressure the effect. In regard to his suggestion that a comparison should be made between a barograph inside and one outside of the building, I think, before satisfactory results could be obtained, it would first have to be proven that the wind in blowing across the top of the barometer cistern, or at right angles to the crevices of such cistern, would not have the same effect of lowering the readings of the barometer outside as well as inside of the building.

Mr. E. B. Weston of Providence has informed me that he has noticed during high winds small oscillations of his barograph, similar to those observed at Blue Hill, and has prevented them by opening the windows, so as to give a free draught of air. I tried the same at Blue Hill during a late high wind, and found that the oscillations, which at most were slight, were reduced by it.

In regard to those large differences between the observed and estimated pressure on Mount Washington, referred to in my last as collected by Professor Loomis, it is probable, that, in these extreme cases, other causes than that suggested by me become factors in the result; such, for instance, as a lagging of the time of minimum pressure at the top as compared with the base, and a more violent cyclonic circulation of the wind at that height, — causes which have been suggested by Professor Loomis in his twentieth paper (*Amer. Journ. Sc.*, vol. xxviii. July, 1884).

H. HELM CLAYTON.

Blue Hill meteor. observ., June 19.

A most extraordinary structure.

Referring to P.Z.S. 1885, p. 908, pl. lxi. fig. 3, *h*, where my amiable young friend Dr. Shufeldt describes and figures the humerus of a humming-bird as 'a most extraordinary structure,' I may be permitted to suggest that some of the alleged 'eccentricities' of this 'unique' bone might seem less if he

had not got the bone turned hind part before by one of those strokes of genius which a prosaic world, steeped in materialism, is slow to appreciate.

A THEOSOPHIST.

Smithsonian institution,
Washington, June 15.

Aspects of the economic discussion.

I have just read Professor Newcomb's article (*Science*, vii. No. 176) on the new school of political economy. It seems to me that the professor asks for too much in the way of results from the new school. As I understand it, this is simply a question of methods. The new school professes the historical method, as opposed to the deductive method of the so-called orthodox school. If the historical method is right, the results eventually arrived at will, nay must, be right. But to stop them on their way as if with a revolver, and demand a categorical statement of their views on such disputed points as state interference before they are allowed to finish their journey, is certainly unwarranted.

Whatever results the new school may reach, it is tolerably certain that they will eliminate from the books that monster of imagination the 'economic man,' and that other *chimaera bombans in vacuo*, the hypothetical 'consumer,' who does nothing in this world but eat.

When they shall have rebuilt the science on their new foundation, it will be soon enough to demand from them an account of their views on such questions as Professor Newcomb propounds.

WM. A. INGHAM.

333 S. 16th St., Philadelphia, June 18.

Distribution of colors in the animal kingdom.

In the notice of Camerano's 'Distribution of colors in the animal kingdom' (*Science*, vii. p. 557) I notice the astonishing statement that green 'never occurs among mollusks.' On the contrary, it is one of the most common colors of mollusks, especially among fresh-water species. Examples will occur to the most superficial observer in the genera *Anodonta*, *Unio*, *Campeloma*, *Anculotus*, etc. Among land-shells the arboreal helices of tropical countries are noted for their magnificent greens. Among marine shells, it is notable in many species of *Mytilus*, *Modiola*, *Tellina*, *Prasina*, etc., among pelecypods; *Neritina*, *Chlorostoma*, *Turbo* (where the calcareous operculum, also, is often stained with green), *Haminea*, and many other gastropods; not to speak of the nudibranchs, which frequently exhibit different shades of green. The rarest color among mollusks is pure blue (as distinguished from the rather common bluish violet), but even this color is found of great brilliancy in some cases. The assertion objected to is one more bit of evidence to the general neglect among biologists, otherwise well equipped, to gain any general knowledge of the Mollusca, except that supposed to be afforded by theoretical views taken from out worn text-books. There are perhaps a dozen first-class general conchologists in the world, none of whom are young. The prospect now is that the next generation will not have any. The reasons seem to be, among others, the shocking state into which amateurs and superficial students have brought the nomenclature, and the fact that the scientific training to be had in our best colleges leads in altogether different directions.

WM. H. DALL.

SCIENCE.—SUPPLEMENT.

FRIDAY, JUNE 25, 1886.

THE PHYSICAL LABORATORY IN MODERN EDUCATION.¹

FROM the moment we are born into this world, down to the day when we leave it, we are called upon every moment to exercise our judgment with respect to matters pertaining to our welfare. While nature has supplied us with instincts which take the place of reason in our infancy, and which form the basis of action in very many persons through life, yet more and more as the world progresses, and as we depart from the age of childhood, we are forced to discriminate between right and wrong, between truth and falsehood. No longer can we shelter ourselves behind those in authority over us, but we must come to the front, and each one decide for himself what to believe and how to act in the daily routine and the emergencies of life. This is not given to us as a duty which we can neglect, if we please, but it is that which every man or woman, consciously or unconsciously, must go through with.

Most persons cut this gordian knot, which they cannot untangle, by accepting the opinions which have been taught them, and which appear correct to their particular circle of friends and associates : others take the opposite extreme, and, with intellectual arrogance, seek to build up their opinions and beliefs from the very foundation, individually and alone, without help from others. Intermediate between these two extremes comes the man with full respect for the opinions of those around him, and yet with such discrimination that he sees a chance of error in all, and most of all in himself. He has a longing for the truth, and is willing to test himself, to test others, and to test nature, until he finds it. He has the courage of his opinions when thus carefully formed, and is then, but not till then, willing to stand before the world and proclaim what he considers the truth. Like Galileo and Copernicus, he inaugurates a new era in science, or, like Luther, in the religious belief of mankind. He neither shrinks within himself at the thought of having an opinion of his own, nor yet believes it to be the only one worth considering in the world ; he is neither crushed with intellectual humility, nor

yet exalted with intellectual pride ; he sees that the problems of nature and society can be solved, and yet he knows that this can only come about by the combined intellect of the world acting through ages of time, and that he, though his intellect were that of Newton, can, at best, do very little toward it. Knowing this, he seeks all the aids in his power to ascertain the truth ; and if he, through either ambition or love of truth, wishes to impress his opinions on the world, he first takes care to have them correct. Above all, he is willing to abstain from having opinions on subjects of which he knows nothing.

It is the province of modern education to form such a mind, while at the same time giving to it enough knowledge to have a broad outlook over the world of science, art, and letters. Time will not permit me to discuss the subject of education in general, and, indeed, I would be transgressing the principles above laid down if I should attempt it. I shall only call attention, at this present time, to the place of the laboratory in modern education. I have often had a great desire to know the state of mind of the more eminent of mankind before modern science changed the world to its present condition, and exercised its influence on all departments of knowledge and speculation. But I have failed to picture to myself clearly such a mind ; while, at the same time, the study of human nature, as it exists at present, shows me much that I suppose to be in common with it. As far as I can see, the unscientific mind differs from the scientific in this, that it is willing to accept and make statements of which it has no clear conception to begin with, and of whose truth it is not assured. It is an irresponsible state of mind without clearness of conception, where the connection between the thought and its object is of the vaguest description. It is the state of mind where opinions are given and accepted without ever being subjected to rigid tests, and it may have some connection with that state of mind where every thing has a personal aspect, and we are guided by feelings rather than reason.

When, by education, we attempt to correct these faults, it is necessary that we have some standard of absolute truth ; that we bring the mind in direct contact with it, and let it be convinced of its errors again and again. We may state, like the philosophers who lived before

¹ Address delivered at the tenth anniversary of the Johns Hopkins university.

Galileo, that large bodies fall faster than small ones; but, when we see them strike the ground together, we know that our previous opinion was false, and we learn that even the intellect of an Aristotle may be mistaken. Thus we are taught care in the formation of our opinions, and find that the unguided human mind goes astray almost without fail. We must correct it constantly, and convince it of error over and over again, until it discovers the proper method of reasoning, which will surely accord with the truth in whatever conclusions it may reach. There is, however, danger in this process that the mind may become over-cautious, and thus present a weakness when brought in contact with an unscrupulous person, who cares little for truth and a great deal for effect. But if we believe in the maxim that truth will prevail, and consider it the duty of all educated men to aid its progress, the kind of mind which I describe is the proper one to foster by education. Let the student be brought face to face with nature; let him exercise his reason with respect to the simplest physical phenomenon, and then, in the laboratory, put his opinions to the test: the result is invariably humility, for he finds that nature has laws which must be discovered by labor and toil, and not by wild flights of the imagination, and scintillations of so-called genius.

Those who have studied the present state of education in the schools and colleges tell us that most subjects, including the sciences, are taught as an exercise to the memory. I myself have witnessed the melancholy sight, in a fashionable school for young ladies, of those who were born to be intellectual beings reciting page after page from memory, without any effort being made to discover whether they understood the subject or not. There are even many schools, so called, where the subject of physics or natural philosophy itself is taught, without even a class experiment to illustrate the subject and connect the words with ideas. Words—mere words—are taught, and a state of mind far different from that above described is produced. If one were required to find a system of education which would the most surely and certainly disgust the student with any subject, I can conceive of none which would do this more quickly than this method, where he is forced to learn what he does not understand. It is said of the great Faraday that he never could understand any scientific experiment thoroughly until he had not only seen it performed by others, but had performed it himself. Shall we, then, expect children and youth to do what Faraday could not do? A thousand times better never teach the subject at all.

Tastes differ, but we may safely say that every

subject of study which is thoroughly understood is a pleasure to the student. The healthy mind as well as the healthy body craves exercise, and the school-room or the lecture-room should be a source of positive enjoyment to those who enter it. Above all, the study of nature, from the magnificent universe, across which light itself, at the rate of 186,000 miles per second, cannot go in less than hundreds of years, down to the atom of which millions are required to build up the smallest microscopic object, should be the most interesting subject brought to the notice of the student.

Some are born blind to the beauties of the world around them, some have their tastes better developed in other directions, and some have minds incapable of ever understanding the simplest natural phenomenon; but there is also a large class of students who have at least ordinary powers and ordinary tastes for scientific pursuits. To train the powers of observation and classification, let them study natural history, not only from books, but from prepared specimens or directly from nature; to give care in experiment, and convince them that nature forgives no error, let them enter the chemical laboratory; to train them in exact and logical powers of reasoning, let them study mathematics: but to combine all this training in one, and exhibit to their minds the most perfect and systematic method of discovering the exact laws of nature, let them study physics and astronomy, where observation, common sense, and mathematics go hand in hand. The object of education is not only to produce a man who *knows*, but one who *does*; who makes his mark in the struggle of life, and succeeds well in whatever he undertakes; who can solve the problems of nature and of humanity as they arise; and who, when, he knows he is right, can boldly convince the world of the fact. Men of action are needed as well as men of thought.

There is no doubt in my mind that this is the point in which much of our modern education fails. Why is it? I answer, that the memory alone is trained, and the reason and judgment are used merely to refer matters to some authority who is considered final, and, worse than all, they are not trained to apply their knowledge constantly. To produce men of action, they must be trained in action. If the languages be studied, they must be made to translate from one language to the other until they have perfect facility in the process. If mathematics be studied, they must work problems, more problems, and problems again, until they have the use of what they know. If they study the sciences, they must enter the laboratory, and stand face to face with nature; they must learn to test their knowledge constant-

ly, and thus see for themselves the sad results of vague speculation; they must learn by direct experiment that there is such a thing in the world as truth, and that their own mind is most liable to error; they must try experiment after experiment, and work problem after problem, until they become men of action, and not of theory.

This, then, is the use of the laboratory in general education, — to train the mind in right modes of thought by constantly bringing it in contact with absolute truth, and to give it a pleasant and profitable exercise, which will call all its powers of reason and imagination into play. Its use in the special training of scientists needs no remark, for it is well known that it is absolutely essential. The only question is, whether the education of specialists in science is worth undertaking at all; and of these I have only to consider natural philosophers or physicists. I might point to the world around me, to the steam-engine, to labor-saving machinery, to the telegraph, to all those inventions which make the present age the 'age of electricity,' and let that be my answer. Nobody could gainsay that the answer would be complete; for all are benefited by these applications of science, and he would be considered absurd who did not recognize their value. These follow in the train of physics, but they are not physics: the cultivation of physics brings them, and always will bring them; for the selfishness of mankind can always be relied upon to turn all things to profit. But in the education pertaining to a university we look for other results. The special physicist trained there must be taught to cultivate his science for its own sake. He must go forth into the world with enthusiasm for it, and try to draw others into an appreciation of it, doing his part to convince the world that the study of nature is one of the most noble of pursuits, that there are other things worthy of the attention of mankind besides the pursuit of wealth. He must push forward, and do what he can, according to his ability, to further the progress of his science.

Thus does the university, from its physical laboratory, send forth into the world the trained physicist to advance his science, and to carry to other colleges and technical schools his enthusiasm and knowledge. Thus the whole country is educated in the subject, and others are taught to devote their lives to its pursuit, while some make the applications to the ordinary pursuits of life that are appreciated by all.

But for myself I value in a scientific mind most of all that love of truth, that care in its pursuit, and that humility of mind, which makes the possibility of error always present more than any other quality. This is the mind which has built

up modern science to its present perfection, which has laid one stone upon the other with such care that it to-day offers to the world the most complete monument to human reason. This is the mind which is destined to govern the world in the future, and to solve problems pertaining to politics and humanity as well as to inanimate nature.

It is the only mind which appreciates the imperfections of the human reason, and is thus careful to guard against them. It is the only mind that values the truth as it should be valued, and ignores all personal feeling in its pursuit. And this is the mind the physical laboratory is built to cultivate.

HENRY A. ROWLAND.

THE FORMATION OF STRUCTURELESS CHALK BY SEAWEEDS.

CHALK has hitherto been believed to be a deep-sea formation only, made up of a fine ooze or mud at great depths, and undoubtedly, so far as the extensive cretaceous deposits are concerned, the explanation is the correct one; but recent observations by Mr. J. Walther on the chalk-secreting algae of the Mediterranean show that its formation often occurs in shallow water. It has been known for some time that the nullipores were chalk-secreting algae, and that under certain conditions, as in the formation of coral islands, they took more or less part in the production of rock. Where their remains are found in any abundance, chalk formations are readily enough ascribed to their agency, but it is now shown that more or less extensive beds, or rather banks, of wholly structureless chalk, whose origin has been oftentimes enigmatical, may be entirely due to seaweeds.

Mr. Walther observed certain forms (*Lithothamnium*) in different places in the Gulf of Naples, growing luxuriantly at a depth of from one to three hundred feet below the surface, and traced out the relation between the masses of dead residual matter and the incompletely transformed beds of fossil chalk. These *Lithothamnia* have a remarkably small proportion of organic material (not more than five or six per cent), nearly the entire substance consisting of mineral matter, chiefly carbonate of lime. The plants reach only the size of one's fist, and do not change their form at death, owing to the small quantity of decaying matter they contain. The living plants secure attachment to the dead ones, forming extensive beds. The numerous stout branches of less than a fourth of an inch in length admit of only small interstices; in slow-growing beds inequalities and shallow depressions may be filled with layers of detritus.

The organic structure disappears to a greater or

less extent, often wholly, so that the chalk becomes entirely structureless; and it has been shown that the absence of structure becomes more apparent in proportion to the greater thickness of beds formed. The further transformation was traced by Walther in a recent tertiary formation at Syracuse, where he found, in the exposed quarries of *Latomia dei Capuccini*, the remains of *Lithothamnium* sufficiently distinct for determination, especially where the interstitial material had been weathered out. The stone, however, blended from this indistinctly structural form to the wholly structureless or homogeneous.

The explanation of this complete transformation, as given by the author, is also of interest. The organic substances, which in the living plant amount to about five or six per cent, were found, in the tertiary chalk above referred to, to be about a third of one per cent. The larger part had thus disappeared; and as the chalk was purely white, showing the absence of all bituminous matter, it was evident that the remaining organic matter had slowly been oxidized, producing carbonic matter, which had obliterated by its dissolving action in the surrounding or percolating water all evidences of structure. In such cases where the plants were exposed to water not impregnated with the carbonic acid, the structure is retained more or less unimpaired.

This explanation of the formation of chalk in shallow waters — for algae must live within a few hundred feet of the surface, where light can reach them — gives a solution of various problems in geology, especially of the more recent chalk-beds. Whether it will apply to the extensive structureless chalk-beds of western Kansas at all, is doubtful.

CYPRUS UNDER BRITISH RULE.

At a recent meeting of the Society of arts, in London, Mr. G. Gordon Hake read a paper on the condition of Cyprus since its occupation by the British, his object being to show the improvements that have taken place under the new administration.

In ancient times Cyprus was one of the most fertile and prosperous countries in the world, its copper and its timber being important articles of commerce. But under the Turkish administration the island deteriorated greatly, as most countries do under Turkish rule. One traveller, near the end of the last century, describes Famagusta, at the time of his visit, as a "melancholy picture of Turkish desolation," and as "almost depopulated, although, in the time of the Venetians, the finest city in the island, and renowned for its brave defence against the infidels." He adds, "The desolation we observed at Famagusta ex-

tended itself along the country. We passed by the ruins of several Greek villages." Another traveller also gives a sad account of Cyprus at a rather later date. "The island," he says, "was formerly one of the richest and most fertile in the world. It is much exposed to the ravages of locusts. On their approach, every kind of verdure disappears, and they even gnaw the very bark off the trees. The Turks will not permit their destruction, because they consider them as sent by the Almighty."

This melancholy condition of the island was due in part to maladministration of justice, and in part to a vicious system of taxation. The Turkish government took tithes of the produce of the land, and these tithes were farmed in the spring of each year to merchants and speculators. This system had its natural results in a loss of revenue to the state, and the impoverishment of the cultivator, whom it involved in the toils of the money-lender, as well as the tithe-farmer, and thus checked the productiveness of the island to an enormous extent. The land, falling out of cultivation, became the breeding-ground of locusts. The cultivators of the soil in many cases gave up their calling in despair, and obtained a living by cutting down and selling trees, and the collection of resin. The wholesale destruction of trees reacted on the climate, and restricted the rainfall; so that between locusts, tithe-farmers, and neglect of the forests, the island, at the time of the occupation, was rapidly becoming more like a barren, rocky desert than a fertile and naturally favored country.

These, then, were the chief evils to be remedied by the English on their arrival in Cyprus. It was at once made plainly known that no farming of tithes would be allowed under British rule; and it was decided to adopt the following course in regard to the same. The Turkish plan of assessment was to be followed, but, instead of collecting the tithes in kind, they were to be valued, and, leaving the peasant free to deal with his crop as he pleased, the money value was to be collected as an ordinary tax later in the year. The sole exceptions to this were the tithes on silk and carobs. The greater portion of these two products being exported from the island, it was arranged to collect the tithe on export, and so save the cost of assessment; and the result, besides being successful from the imperial point of view, has given great satisfaction to the agriculturists.

After this financial reform the locust and timber questions remained to be dealt with. The Cyprus locust is indigenous to the island; and its presence is, without doubt, largely due to past

mismanagement and neglect of the soil, inasmuch as it is only on rocky waste ground that the female insect will lay her eggs. The locust-plague is therefore the result of inadequate cultivation of the soil, consequent upon a deficiency of population, coupled with an insufficiency of trees; though their increase may be largely attributed to the Mussulman theory of resignation, which would not, in former times, permit their destruction on account of the belief that they were sent by the Almighty. For some years prior to 1862 the destruction of crops from this cause was very large, and the plan of egg-collection was then tried, without success, by the Turkish government. This led Mr. Richard Mattei, a land-owner of Cyprus, to commence a series of experiments, which resulted in the invention of his system of traps and screens. Mr. Mattei had the good fortune to secure the assistance of the Turkish governor, Said Pacha, a man of exceptional intelligence and energy; and in 1870, after long effort, the locusts were by this means almost exterminated. Not wholly, however; for in 1875 they reappeared, and, another governor being in power, they were allowed to increase until the time of the British occupation. Early in 1879, measures were adopted by the English government, both by the employment of Mr. Mattei's trap and screen system and by encouraging the collection of locust-eggs, for which they offered a considerable price. These measures have been completely successful, as the locusts that appeared last year were comparatively few in number, and did no appreciable damage, and any future visit may be looked forward to with complacency.

But the forests of the island also demanded and received the attention of the new authorities. The forests were placed under control, and the destruction of wood prohibited, moderate supplies being permitted for native wants. The indiscriminate pasturage of goats has been stopped, and a large number of trees have been planted, the chief species being Aleppo pine, cypress, carob, ailantus, oak, mimosa, eucalyptus, and Pinus pinea. The effect of these measures has been favorable; but the restoration of the forests must necessarily be a work of time.

Again, it was necessary to reform the administration of justice throughout the island. This was effected by a complete re-organization of the department of justice under the direction of the home government. The most salient features of the scheme were the formation of a court of appeal, composed of two qualified English judges, the appointment of an English judge to preside in every district, and the establishment of a number of village judges to deal with petty civil

cases. It included also the adequate payment of the native judges, although their number was gradually reduced to a considerable extent, and likewise established a system of jail deliveries by judges on circuit, similar to that which prevails in England.

The effect of these and other less important reforms on the commerce of the island has been highly beneficial. The abolition of the tithe-farming system, and the adoption of the more generous as well as more politic measure, whereby the agriculturist was permitted to deal with his crop as he pleased, the collection of the tax being delayed till a later season, when he should have had ample time for the conversion into money of the produce of his holding, had a most favorable influence on the particular industries affected, and consequently on the trade of the island generally. The volume of foreign trade, which in Turkish times was estimated at £1 10s. per head of the population, amounted, in 1879, to £2; in 1880, to £2 10s.; and in 1881, to £3 per head, since which time steady increases have been recorded. The net result of British occupation to Cypriot commerce may be fairly estimated by a comparison of the respective imports and exports for 1878, the last year of Ottoman rule, with those of 1884-85. The imports for 1878 were £177,651; for 1884-85, £304,375. The exports in 1878 were £157,328; last year they amounted to £287,521; and the figures were still higher the year before, especially as regards the imports.

Mr. Hake concluded his paper with a few remarks on the further improvements which he deems necessary for the prosperity of the island. Leaving out of account all minor measures, such as developing certain crops, he thinks there are three things which remain for the English to do. The first is to become the purchasers of the fee simple of the island, instead of being tenants at will, as they are at present; the second is to spend money, even to the extent of getting into debt, in order to plant the mountain-ranges, and especially the northern one that runs down the Mesaorian plain; and the third is (again getting into debt, if necessary) the establishment of a railway from Morphou to Famagusta, leaving its after-development to time, and to put the harbor of Famagusta into proper repair for mercantile use.

JEVONS'S LETTERS AND JOURNAL.

MRS. JEVONS has done well to collect these letters and journals of her late husband. The world is always interested in the personal history

Letters and journal of W. Stanley Jevons. Ed. by his wife. London, Macmillan, 1886. 8°.

of its benefactors; and, in the case of those whose lives are uneventful, this can only be known from their own private papers and those of their friends. Jevons was not, indeed, a man of the highest genius, and his works are not likely to make an epoch in any department of knowledge; but they are fresh in thought and often original, and nearly always provocative of thought in his readers. Moreover, he wrote a clear and easy style, which makes his letters interesting from a literary point of view.

Most of the letters in the collection before us were written to his relatives and personal friends, though many of the later ones are addressed to correspondents in the learned world. The most interesting part of the book to us is that which treats of the author's education and his early labors in the mental and social sciences. William Stanley Jevons was born in Liverpool in 1835, and met his death by drowning, at Bulverhythe, near Hastings, in 1882; so that his life covered a period of not quite forty-seven years. His father was a merchant, but failed while Stanley was a boy, after which the family were in only moderate circumstances. Stanley's mother died while he was very young, and he was taught at home by a governess until he was more than ten years old, when he was sent to school in Liverpool. At the age of fifteen he went to London to attend University college school, and afterwards studied at the college itself till he reached the age of nineteen. At that time he was offered the position of assayer in the mint at Sydney, in Australia; and, though at first averse to taking it, he ultimately accepted and retained the post for four years. The duties of the office seem never to have been much to his taste, and he had not held it long when he began to entertain designs and aspirations which rendered a return to England necessary. What these designs were he makes known in a letter to his sisters. He writes that in his inmost soul he has but "one wish, or one *intention*, viz., to be a *powerful good* in the world. To be *good*, to live with good intentions towards others, is open to all. . . . To be *powerfully good*, that is, to be good, not towards one, or a dozen, or a hundred, but towards a nation or the world, is what now absorbs me. But this assumes the possession of the *power*. . . . I also think, that, if in any thing I have the chance of acquiring the power, it is that I have some *originality*, and can strike out new things" (pp. 95, 96).

It appears, also, from another of his letters, that he had also chosen the field in which he was to work; for he writes that he intends "exchanging the physical for the moral and logical sciences, in which my *forte* will really be found to lie."

With such aspirations as these, Jevons could not be content to remain in Australia; and accordingly in 1859 he left his post at Sydney, and returned to England by way of Panama and the United States. On reaching home, he returned to study at University college, where he remained till he had taken the degree of M.A., devoting himself mainly to mental and social philosophy. After finishing his studies, he was for some time in doubt as to how he was to get his living, but was soon offered a position as tutor in Owens college, Manchester, which he accepted, being then twenty-eight years of age. A few years later he was appointed professor of philosophy and political economy in the same institution, and not long afterwards he married.

He had now attained a position which enabled him to carry on his chosen work, and he had already published some essays which had given him a reputation as an economist and statistician. The most important of these was the one on the coal-question, in which he warned his countrymen that their supply of coal was not inexhaustible. These essays did not at first attract the notice he expected, and, as he had not then attained his professorship, he seems to have suffered much from depression of spirits. Yet he did not swerve in the least from his chosen path; for he writes in his journal as follows: "Whence is this feeling that even failure in a high aim is better than success in a lower one? It must be from a higher source, for all lower nature loves and worships success and cheerful life. Yet the highest success that I feel I can worship is that of adhering to one's aims, and risking all" (p. 218). The next day after this was written, he received a letter from Mr. Gladstone, warmly commending his pamphlet on the coal-question; and from this time onward his reputation continued to grow.

Of the author's works, however, we have no space to speak at length. We cannot accord him a place among the great thinkers of the world, and it seems to us that he tried to be more original than he had the power to be, though his works are very suggestive. His mathematical theory of political economy has not been accepted by any leading thinker, and has remained thus far without influence on the development of the science. He urges that economical phenomena can be treated mathematically, because they can be expressed in terms of more and less; but, in order to treat them mathematically, we must be able to say how much more or less, and this, in the case of human desires and efforts, is impossible. Again: Jevons seems to have thought, that, in his doctrine of 'the substitution of similars,' he had presented an entirely new theory of reasoning; whereas the

doctrine in question is the basis of every system of logic in existence, and necessarily so.

Jevons was perhaps a little too apt to present his thoughts to the public before he had given them time to mature, and hence some of his theories are crude and but half worked out. Indeed, he seems in some cases to have been aware of this himself; for he writes to one of his correspondents about the 'Principles of science,' in the following terms: "To the want of a psychological analysis of the basis of reasoning I plead guilty. . . . No doubt, to a considerable extent I have avoided the true difficulties of the subject; but this does not preclude me from attempting to remedy the defect at some future time, if I live long enough, and can feel that I see my way to a more settled state of opinion" (p. 322). But, unfortunately for him and for us, he did not live long enough to finish this and other tasks that he had projected; and it is sad to think how much the world may have lost by the death, at the age of forty-six, of a man of such freshness of thought, and courage of opinion, as Jevons undoubtedly showed.

THE RAILWAYS AND THE REPUBLIC.

CAN competition be so arranged as to prevent the more serious abuses of railroad power? Can it be made to apply to railroads as it does to most other lines of business? Fifty years' experience has seemed to show that it cannot. Mr. Hudson believes that it can; and he makes out a case which will appear plausible to those who are not in a position to understand the practical difficulties involved in his project.

Each year's history shows that under our existing system—or want of system—railroad managers wield an irresponsible power, dangerous alike to shippers and to the government. By arbitrary differences in charge they can ruin the business of individuals; by political corruption they can often thwart all attempts at government control. The history of the Standard oil company, which Mr. Hudson tells extremely well, furnishes an instance of both these things. The railroads made a series of contracts with the company to do its business at much lower rates than they would give to any one else; while the railroads and the company together were able to set at naught the plainest principles of common law, to defy legislative investigation, and laugh at state authority itself.

What is to be done under these circumstances? This is the question to which Mr. Hudson addresses himself. He does not fall into the extreme of

advocating state ownership. He has too strong a sense of the dangers of government management to believe that political corruption could be avoided, or enlightened economy secured, by a measure like this. Admitting, then, that railways are to remain under private ownership, how are their abuses to be brought under control? Almost every writer has his own notion on the subject, and his own individual shade of opinion; but we may group them under three main heads:—

1. There is one class of writers who insist that things are well enough as they are; who say that the reduction in rates under our present system has been so great, and the development of the country so rapid, as to outweigh any incidental evils which may exist. They say that the most we can possibly think of doing is to prohibit a few of the worst abuses, and perhaps secure a very moderate amount of publicity; and that other things will take care of themselves. This is the position of writers like Stuart Patterson or Gerritt Lansing.

2. Many of the more enlightened railroad men, like Albert Fink, G. R. Blanchard, or Charles Francis Adams, jun., do not deny the existence of most serious evils; but they attribute them to unrestricted competition, which favors competing points at the expense of local points, or places solvent roads at the mercy of bankrupt ones. They favor legalizing pools, and limiting the irresponsible construction of new roads, and think that the public interest would be best served by a responsible combination of railroads, with a commission to see that the interests of the shippers were not neglected.

3. On the other hand, Mr. Hudson insists that we have, not too much competition, but too little; that the abuses incident to its partial and irregular working can be best avoided by enabling it to act everywhere instead of nowhere. This he proposes to do by allowing others besides the railway company to use the track, on payment of a just and reasonable toll. He argues strongly to prove that this plan is not merely equitable, but practicable, and that each of the other positions is wrong, both in fact and in morals.

He has no difficulty in breaking down the arguments of the first group. The men who insist that railroad management is a private business, with which there should be no interference, and that all is well enough as it is, are every day becoming fewer. The really difficult conflict is against those who admit the evils, but who say that the remedy is to be found in well-controlled combination rather than uncontrolled competition. Mr. Hudson insists that combinations perpetrate outrages which individual roads could not perpe-

trate, and that the worst abuses of railroad wars have their origin in the desire to force rival roads to a combination. Against the first of these points we may cite the testimony of Mr. Sterne, — certainly no prejudiced witness, — that the actual abuses have been lessened rather than increased when the trunk-line pool was in operation. We may cite the uniform experience of Europe, that only where pooling contracts were made permanent has it been possible to bring discrimination under control; so that men as widely distinct in their views as Gladstone and Bismarck have both sanctioned the system by their active countenance. With regard to the motive for railroad wars, we may show that it is regularly the weaker party who is the aggressor, rather than the stronger party. And finally, as a counter-argument against Mr. Hudson, it may be shown that his scheme has been found impracticable. It was tried and abandoned at the outset, as he himself admits. Every subsequent change in railroad administration has rendered the difficulties of its application greater instead of less. Both by theory and by experience, it may be shown that the attempt to treat the railway as a public highway has done some harm and no good in the past, and must grow even less possible with the increasing complication of railroad business.

OPPOLZER'S TREATISE ON ORBITS.

OPPOLZER'S treatise on the determination of the orbits of planets and comets is so well and so favorably known to students of astronomy, that, in calling attention to the French translation of the first volume (which will be found welcome by those who do not read German with ease), we might have confined ourselves to the briefest notice, if the translator had reproduced the German edition without modification. M. Pasquier has, however, introduced, together with several minor changes, the mode of counting longitude and time recommended by the Washington international meridian congress of 1884: that is, longitudes east from Greenwich are regarded as plus, and west as minus; and the astronomical day is made to begin with mean midnight. This innovation is in accord with the ideas of Dr. Oppolzer, who is known as one of the strongest and most distinguished of the advocates of the new plan. M. Pasquier says that the change has been made in response, also, to the wishes of the majority of astronomers and of governments. It is difficult to see upon what ground such a conclusion is drawn in regard to the wishes

of astronomers; the opinions published during the past year are far from indicating a majority in favor of the change; and diplomatic action, even if ratified by the countries represented, can scarcely be expected to influence astronomers in such an important matter. The course adopted by M. Pasquier we are inclined to regard as somewhat premature, and it may interfere with the general acceptance and usefulness of the translation as a text-book; but he has taken care to indicate in his preface the corrections which must be made in the text and tables, if one prefers to reckon the astronomical day from mean noon (the present custom) instead of using universal time. To quote a recent comment, "a glance at these corrections will show astronomers some of the troubles that are in store for them, should they make the change which the Washington conference has recommended."

The typography of the volume is good (we are always sorry, though, to meet with the flat-topped figure three (3), an abomination when it is found on divided circles and micrometer heads, and scarcely more legible in print), and especial pains have been taken to insure accuracy in the tables and formulae. The tables, we are told, were revised three times while the work was going through the press.

THE fourth volume of the 'Publications of the Washburn observatory,' which we have just received, seems to bring to a close the work undertaken at Madison by Professor Holden. The greater part of the volume is taken up with the work of the Repsold meridian circle for 1884 and 1885, — the observation of the 303 stars which are to serve as reference-points for the southern zones of the *Astronomische gesellschaft*. A casual glance shows a satisfactory performance of the instrument; but we regret with Professor Holden, that, under the circumstances, it has been possible to give merely the "results of observation, instead of accompanying them with the thorough discussion they seem to deserve." We note particularly the creditable part taken in both observations and reductions by Miss Alice Lamb, who appears in the *personnel* as one of the 'assistant astronomers.' A valuable piece of astronomical bibliography will be found in the seven pages devoted to a reference-list of the original sources from which errata have been taken in systematically correcting the star-catalogues contained in the observatory library. Some thirty pages are occupied with the results of meteorological observations; and a brief discussion is given of a longitude campaign undertaken, in co-operation with a government surveying party, to determine the western boundary of Dakota.

Traité de la détermination des orbites des comètes et des planètes. Par THEODORE D'OPPOLZER. Tr. by Ernest Pasquier. Vol. i. Paris, Gauthier-Villars, 1886. 4°.

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ERRATA.

Page 131, col. 2, 4th line from top, for 'times' read 'lines.' " 131, " 2, 32d line from top, for 'sciences' read 'science.' " 132, " 1, 1st line, for 'points to' read 'points.' " 188, " 2, 27th line from bottom, for 'fifteen' read '1.5.' " 250, " 2, 21st line from bottom, for 'two thousand' read 'two.' " 395, " 2, 33d line from top, for 'Zygodium' read 'Lygodium.'	Page 492, col. 1, 2d line from bottom, for 'abilities' read 'utilities.' " 535, " 2, 28th line from top, for 'them' read 'these.' " 535, " 2, 12th line from bottom, for 'Zaphrentes' read 'Zaphrentis.' " 536, " 1, 27th line from bottom, for 'probably' read 'possibly.' " 536, " 1, 22d line from bottom, for 'Tahleh' read 'Zahleh.' " 536, " 2, 14th line from top, for 'there' read 'these.'
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